Experiments on Teleoperation of Ground Robots using Motion Primitives

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Research Objective

In this work, we develop a motion primitives based teleoperation approach for ground robots to enable safe and fast teleoperation.

In [1], authors present results assuming a perfect state estimate for a quadrotor vehicle. This work pursues field results and performance evaluation given laser based state estimation.

Methodology

- User acts as a high level planner and tries to follow a trajectory as shown in the experimental setup below.
- One primitive is selected out of the motion primitive library and is passed to the trajectory tracking controller.
- Proportional Derivative error based controller tracks the trajectory.

Approach

Forward Arc Motion Primitives

- Trajectories marked grey are dynamically feasible trajectories available to the user to follow based on the joystick input.
- Red trajectory is the one selected by the user.

Predicting User’s Intent and Adapting Primitives.

- User’s intent is predicted using Locally Weighted Projection Regression (LWPR) [1].
- Primitives shown in grey are adapted with respect to a belief distribution obtained from user’s intent model.

Preliminary Teleoperation Experimental Results

Test environment used for ground robot teleoperation tests. The user navigates the robot around the black obstacles. The white line on the ground is provided as a reference.

Conclusion

- Adaptive Teleoperation strategy shows promising results in terms of time taken to complete the trajectory.
- The trajectories followed in the case of assisted teleoperation are smoother than in the case of simple differential drive teleoperation.

Future Work

- Extend the adaptive teleoperation approach to enable tracking more agile and aggressive trajectories.
- Extend approach to consider aerial robots and multi-agent systems.

References

1. Xuning Yang, Koushil Sreenath and Nathan Michael, “A Framework for Efficient Teleoperation via Online Adaptation” International Conference on Robotics and Automation (ICRA), 2017